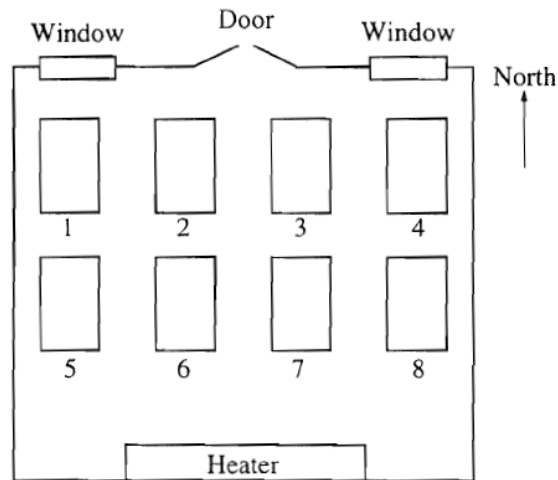


Experimental Design Handout

1997

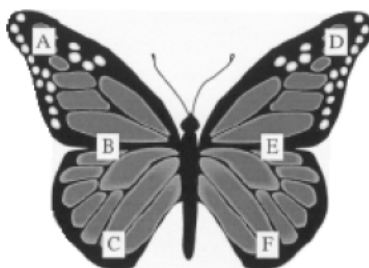
2. A new type of fish food has become available for salmon raised on fish farms. Your task is to design an experiment to compare the weight gain of salmon raised over a six-month period on the new and the old types of food. The salmon you will use for this experiment have already been randomly placed in eight large tanks in a room that has a considerable temperature gradient. Specifically, tanks on the north side of the room tend to be much colder than those on the south side. The arrangement of tanks is shown on the diagram below.



Describe a design for this experiment that takes account of the temperature gradient.

1998

3. Researchers often mark wildlife in order to identify particular individuals across time or space. A study of butterfly migration is designed to determine which location on the butterflies' wings is best for marking. The six possible locations are those shown as A through F in the figure below. The butterfly in the figure is a monarch (*Danaus plexippus*).



Because marks in certain locations may be more likely to attract predators or cause problems than marks in other locations, the goal is to determine whether the six marking locations result in equivalent chances of successful migration. To test this, researchers plan to mark 3,600 butterflies and release them, then count how many arrive displaying each marking location at the end of the migratory path.

- Briefly describe a method you could use to assign the marking locations if you wanted to ensure that exactly 600 butterflies were marked in each location.
- Briefly describe a method you could use to assign the marking locations if you wanted to be independent from one butterfly to the next, and wanted each location assigned with a probability $1/6$ each time.

3. The dentists in a dental clinic would like to determine if there is a difference between the number of new cavities in people who eat an apple a day and in people who eat less than one apple a week. They are going to conduct a study with 50 people in each group.

Fifty clinic patients who report that they routinely eat an apple a day and 50 clinic patients who report that they eat less than one apple a week will be identified. The dentists will examine the patients and their records to determine the number of new cavities the patients have had over the past two years. They will then compare the number of new cavities in the two groups.

- Why is this an observational study and not an experiment?
- Explain the concept of confounding in the context of this study. Include an example of a possible confounding variable.
- If the mean number of new cavities for those who ate an apple a day was statistically significantly smaller than the mean number of new cavities for those who ate less than one apple a week, could one conclude that the lower number of new cavities can be attributed to eating an apple a day? Explain.

2000

5. High cholesterol level in people can be reduced by exercise or by drug treatment. A pharmaceutical company has developed a new cholesterol-reducing drug. Researchers would like to compare its effects to the effects of the cholesterol-reducing drug that is currently available on the market. Volunteers who have a history of high cholesterol and who are currently not on medication will be recruited to participate in a study.

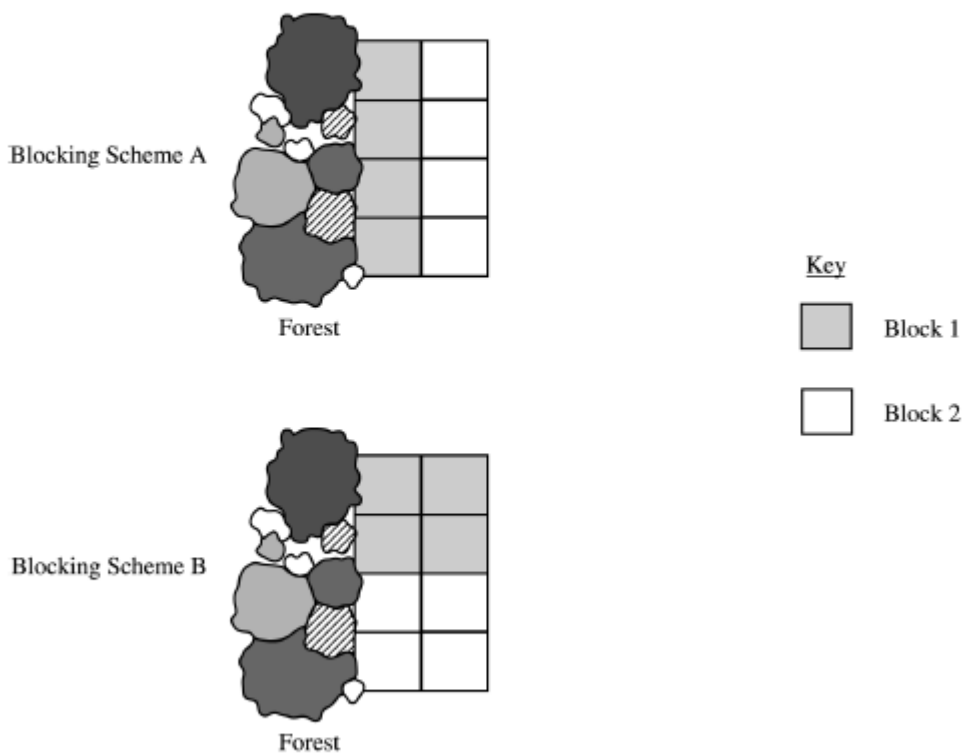
(a) Explain how you would carry out a completely randomized experiment for the study.

(b) Describe an experimental design that would improve the design in (a) by incorporating blocking.

(c) Can the experimental design in (b) be carried out in a double blind manner? Explain.

4. Students are designing an experiment to compare the productivity of two varieties of dwarf fruit trees. The site for the experiment is a field that is bordered by a densely forested area on the west (left) side. The field has been divided into eight plots of approximately the same area. The students have decided that the test plots should be blocked. Four trees, two of each of the two varieties, will be assigned at random to the four plots within each block, with one tree planted in each plot.

The two blocking schemes shown below are under consideration. For each scheme, one block is indicated by the white region and the other block is indicated by the gray region in the figures.



- (a) Which of the blocking schemes, A or B, is better for this experiment? Explain your answer.
- (b) Even though the students have decided to block, they must randomly assign the varieties of trees to the plots within each block. What is the purpose of this randomization in the context of this experiment?

2002

2. A manufacturer of boots plans to conduct an experiment to compare a new method of waterproofing to the current method. The appearance of the boots is not changed by either method. The company recruits 100 volunteers in Seattle, where it rains frequently, to wear the boots as they normally would for 6 months. At the end of the 6 months, the boots will be returned to the company to be evaluated for water damage.
 - (a) Describe a design for this experiment that uses the 100 volunteers. Include a few sentences on how it would be implemented.
 - (b) Could your design be double blind? Explain.

4. Because of concerns about employee stress, a large company is conducting a study to compare two programs (tai chi or yoga) that may help employees reduce their stress levels. Tai chi is a 1,200-year-old practice, originating in China, that consists of slow, fluid movements. Yoga is a practice, originating in India, that consists of breathing exercises and movements designed to stretch and relax muscles. The company has assembled a group of volunteer employees to participate in the study during the first half of their lunch hour each day for a 10-week period. Each volunteer will be assigned at random to one of the two programs. Volunteers will have their stress levels measured just before beginning the program and 10 weeks later at the completion of it.
- (a) A group of volunteers who work together ask to be assigned to the same program so that they can participate in that program together. Give an example of a problem that might arise if this is permitted. Explain to this volunteer group why random assignment to the two programs will address this problem.
 - (b) Someone proposes that a control group be included in the design as well. The stress level would be measured for each volunteer assigned to the control group at the start of the study and again 10 weeks later. What additional information, if any, would this provide about the effectiveness of the two programs?
 - (c) Is it reasonable to generalize the findings of this study to all employees of this company? Explain.